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Nr. 2. Aage J. C. Jensen: INVESTIGATIONS OF THE PLAICE STOCK IN THE SOUTHERN HORNS REEF AREA IN THE YEARS 1928—1930

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1931

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INVESTIGATIONS OF THE PLAICE STOCK IN THE SOUTHERN HORNS REEF AREA IN THE YEARS 1928—1930

BY

AAGE J. C. JENSEN

KØBENHAVN
C. A. REITZELS FORLAG
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1931

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I. The material for the investigation.

Quantitative fishing experiments with a fifty feet ottertrawl with a fine meshed cod-end were carried out from s.s. "Dana" in the southern Horns Reef area from the 23rd to the 27th October 1930. A total of 2625 plaice were caught in 15 localities at depths varying from 11 to 34 m. At three stations only representative samples of the catch were examined for age so that in all 1948 plaice were age-determined. All the plaice were measured. The material from each of the stations is given in tables at the end of this paper.

This is a continuation of the investigations carried out in the autumn of 1922 and 1925 and the spring of 1925 and 1927[1].

There are in addition investigations, from 1928, 1929 and 1930, regarding the ages and lengths in the catches made in April from fishing cutters with a Danish seine at depths ranging from 10 to 25 m. These investigations were made in connection with the transplanting of plaice to the inner Danish waters. The following is the number of plaice examined:

1928	439	plaice	investigated,	length	13—30 cm.
1929	867	—	— ,	—	14—26 -
1930	105	—	— ,	—	17—28 -

II. Numbers and Distribution of the total stock of plaice in the southern Horns Reef Area in 1930 compared with previous years.

The results of the fishing experiments in respect of the distribution of the total population and of the different age and size groups are shown on the charts Fig. 1 and 2. They show, as known from previous investigations, the distribution according to the depth with the greatest density of the total population at depths less than 30 m. and the considerable variation in density from locality to locality within the same depth zone.

To facilitate a survey which can be compared with the results of the investigations of previous years, the material has been arranged according to depths zones of 10—20 m., 20—30 m. and 30—40 m. In table 1 the material is arranged according to size groups, in table 2 according to age groups.

[1] Vide Aage J. C. Jensen: An investigation of the stock of Plaice in the Southern Horns Reef Area in the years 1925 and 1927. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. VIII. No. 6. 1928.

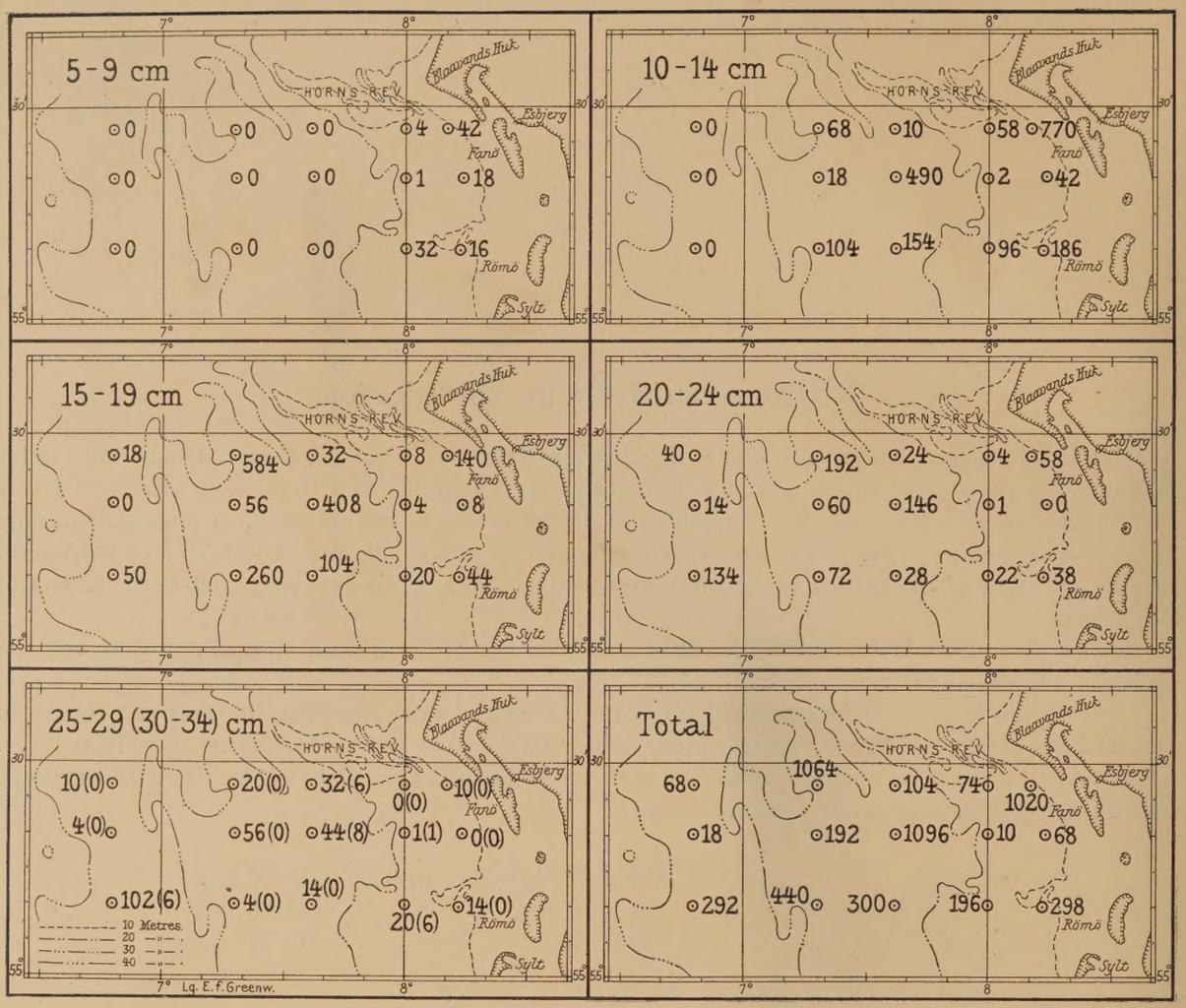

Fig. 1. Showing numbers of plaice of the different size groups and total number caught per hour from s.s. "Dana" by a 50 ft. otter trawl with extra codend. — October 1930.

Table 1. Average numbers of plaice of the various size groups caught per hour with 50 feet otter trawl in the autumn of 1930 (October 23rd—27th) in the southern Horns Reef Area between the 10 and the 40 metres lines.

Depth-zone m.	Number of stations	Size groups, cms.						Total
		5—9	10—14	15—19	20—24	25—29	30—34	
10—20	6	19	192	37	20	8	1	278
20—30	5	0	155	172	66	30	3	426
30—40	4	0	17	163	95	34	2	360

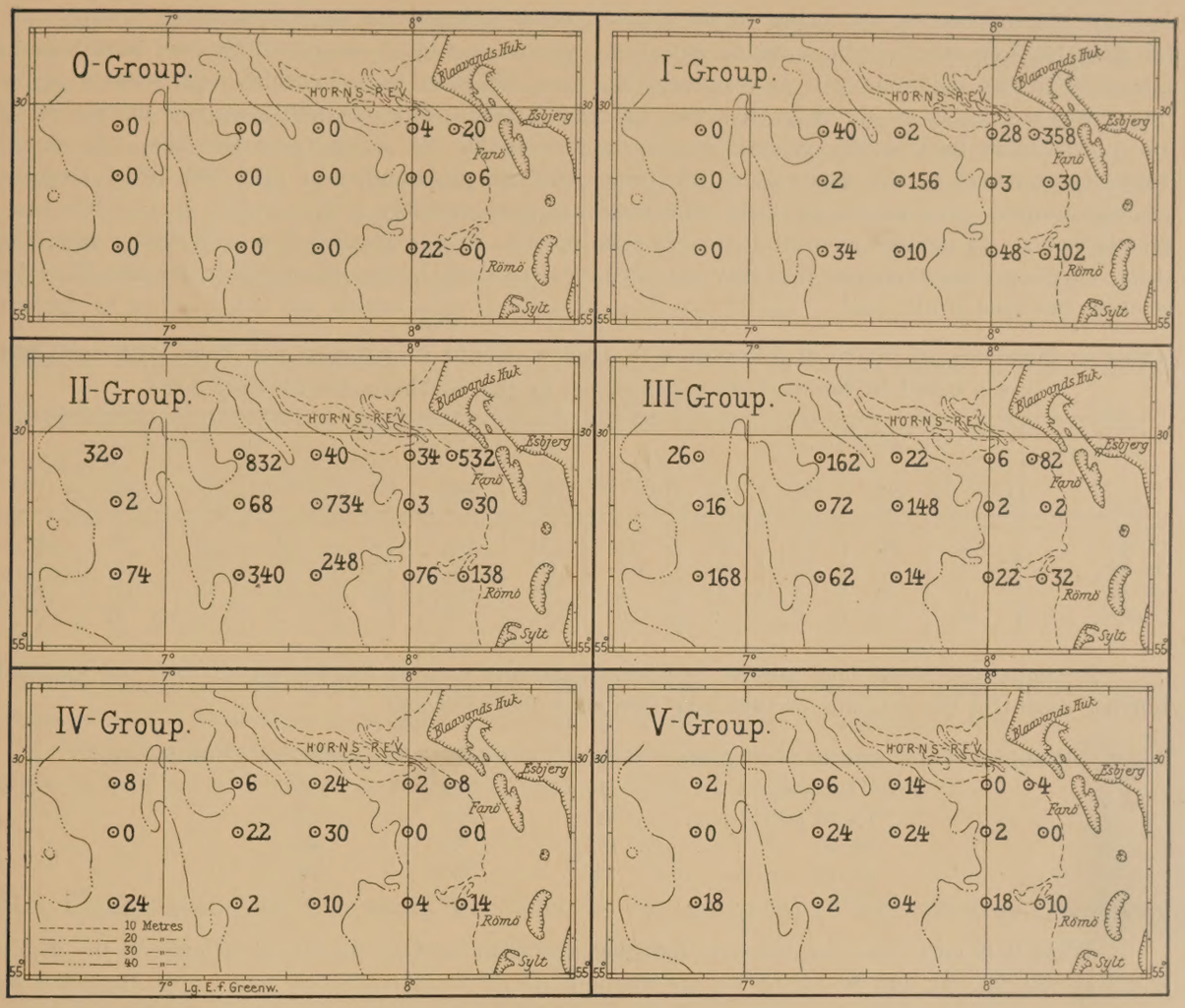

Fig. 2. Showing numbers of plaice of the different age groups caught per hour from s.s. "Dana" by a 50 ft. otter trawl with extra codend. — October 1930.

Table 2. Average numbers of plaice of the various age groups caught per hour with 50 feet otter trawl in the autumn of 1930 (October 23rd—27th) in the southern Horns Reef Area between the 10 and the 40 metres lines.

Depth-zone m.	Age groups and year classes									
	0 1930	I 1929	II 1928	III 1927	IV 1926	V 1925	VI 1924	VII 1923	VIII 1922	?
10—20	9	95	135	24	5	6	0	0.3	0	4
20—30	0	41	286	63	15	14	0	0	0.4	4
30—40	0	10	235	93	10	6	0	0	0	6

If the numbers of the plaice of the different depth zones in the years from which investigations are available from the area in question during the autumn months, is compared, as they have been in table 3, it is seen that from year to year there is a great difference as to, in which depth zone a particular size group has its centre of gravity. This difference is particularly noticeable as regards the size group 15—19 cm. As in 1903—04 the greatest densities were found in the depth zones 10—30 m. whereas in 1930 they occurred in the depth zones 20—40 m. while the distribution in 1922 and 1925 occupy a medium position. The reason for these differences are most probably to be found in the nutritive conditions, but at the present moment it doesn't seem possible to give a satisfactory explanation regarding them. I have previously shown that they are not to be explained by the differences in the density of the stock in the open North Sea[1].

Table 3. Numbers of plaice of different size groups caught in autumn per hour with a 50 feet otter trawl in the various depth-zones in the southern Horns Reef Area.

Depth-zone m.	Size group 10—14 cm.				Size group 15—19 cm.				Size group 20—24 cm.			
	1903—04	1922	1925	1930	1903—04	1922	1925	1930	1903—04	1922	1925	1930
10—20.....	172	287	66	192	96	94	155	38	37	12	59	20
20—30.....	38	429	58	156	215	197	385	172	107	23	170	66
30—40.....	0	51	0	16	4	97	110	162	100	69	187	96
> 40	0	0	0	?	0	1	0	?	1	6	11	?

A comparison of the total number of plaice caught per hour in the autumn of 1930 and the total number caught in the autumns of 1922 and 1925 gives the following:

Table 4. Total numbers of plaice caught per hour in the different depth-zones.

Depth-zone	1922	1925	1930
10—20 metres.....	678	373	278
20—30 —	672	722	426
30—40 —	226	372	360
> 40 —	13	49	?

When it is taken into consideration that the proportion between the size of the areas of the depth-zones 10—20, 20—30, and 30—40 m. for the southern Horns Reef Area, when bounded on the south by 55.00 N. lat. and on the north by Horns Reef and 55.33′ N. lat., may be reckoned to be 1 : 2 : 1 (Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. VIII. Nr. 6. 1928, p. 8) it will be seen that the total number of plaice found in the autumn of 1930, between the depths of the 10 and 40 m. curve, was about two thirds of the aggregate number in 1922 or 1925.

One of the reasons for the difference is, that the two youngest age groups in 1930 were more sparsely represented than in 1922 and 1925. As the number of these age groups is determined with some uncertainty, because they have their principal distribution in water shallower than 10 m. a comparison has been made, in table 5, of the number of plaice of groups II—VI caught in the autumns of 1922, 1925 and 1930.

Table 5. Numbers of plaice of age groups II and older caught per hour in the various depht-zones.

Depht-zone	1922	1925	1930
10—20 metres.....	220	227	170
20—30 —	390	670	378
30—40 —	210	371	344
> 40 —	13	49	?

[1] Aage J. C. Jensen: 1928 l. cit. p. 44.

It will be seen that the difference of the year 1930 from 1922 is exclusively owing to the age groups 0 and I of 1922 being far more numerously represented than in 1930, while the age groups II—VI in this area was represented by about equal quantities both the years. The difference from 1925 is due particularly to a decrease in the number of plaice of age groups III—VI. The numbers of these caught per hour in the three depth-zones 10—20, 20—30, 30—40 m. in October 1925 were 135, 437 and 321 respectively, in 1930 they were 34, 96 and 108 respectively, that is, only about a quarter as many plaice.

In spite of there being some improvement in growth as regards age groups III—V between 1925 and 1930, as much as their average length in 1930 proved to be 1—2½ cm. greater than in 1925 (vide page 12) there is, as table 6 shows, therefore a considerable difference between 1925 and 1930 in the number of plaice of the size groups over 15, over 20, and over 25 cm.

Table 6. Numbers of plaice over 15, over 20 and over 25 cm. in length caught per hour in the different depth-zones.

Depth-zone m.	> 15 cm.			> 20 cm.			> 25 cm.		
	1922	1925	1930	1922	1925	1930	1922	1925	1930
10—20	108	226	66	14	71	29	2	12	9
20—30	223	648	271	26	263	99	3	93	33
30—40	175	371	294	78	261	131	9	74	36
> 40	12	50	?	11	50	?	5	39	?

It will be seen that in the examined area, out to the 30 m. curve, from two to three times as many plaice of each of these sizes were found in the autumn of 1925 as in the autumn of 1930.

According to A. BÜCKMANN's investigations the decrease of recent years in the density of the stock, seems to be a common feature of the nursery grounds of the south-eastern North Sea[1].

III. Composition of the stock of plaice as to age groups. The relative frequency of year classes.

The composition of the plaice population as to age groups in the autumn of 1930 is shown in table 2 and a graphic presentment of the same is given in Fig. 3.

From this the relative frequency of the year classes can be determined.

It will be seen that age groups IV and V at the depths between 10 and 40 m. were represented almost equally, in accordance with the fact, that the year class 1925 was richer than that of 1926.

If we compare the catch per hour for the individual age groups in the autumn of 1930 with the corresponding values for the catch in the autumn of 1925 as given in Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. VIII. Nr. 6. 1928 table 4 p. 6 it will be seen that the year class 1927 was considerably poorer than the rich year class 1922, that year class 1928 was richer than year class 1923 the yield of which was, as we know, about normal, and that year class 1929 was about equally as weak as the poor year class 1924. Finally it seems that from the great difference in the quantity of the 0-group those two years, we may venture to conclude that year class 1930 was far weaker than the rich year class 1925.

That each of the age groups IV and V (the year classes 1926 and 1925 respectively) during the fishing experiments in the autumn of 1930 were found in such very much smaller numbers than those

[1] A. BÜCKMANN: Die Alterszusammensetzung des Schollenbestandes der südöstlischen Nordsee im Jahre 1929. — Journal du Conseil. Vol. V. Nr. 1. 1930 p. 52.

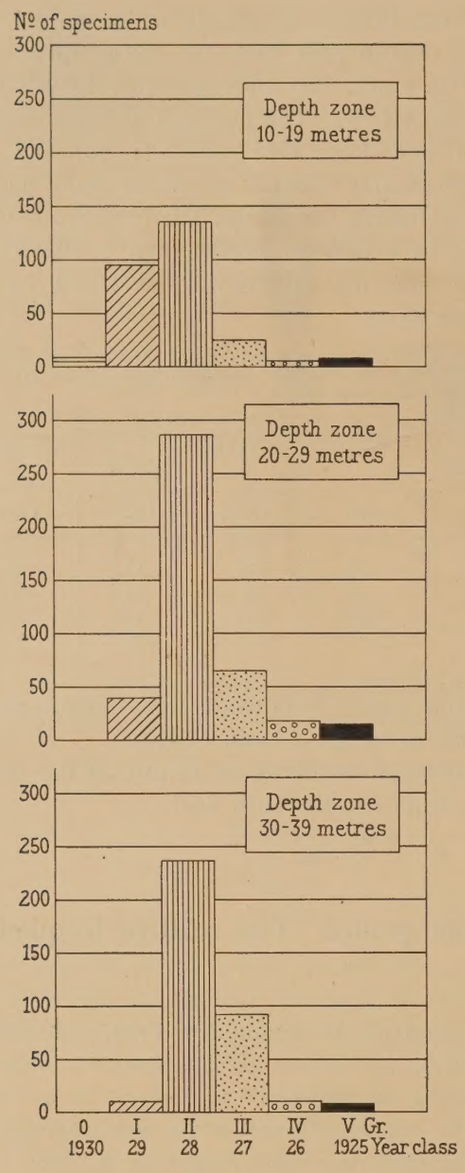

Fig. 3.

Fig. 3. Showing mean catch of the various age groups taken per hour with a 50 ft. otter trawl in the different depth-zones of the southern Horns Reef Area in October 1930.

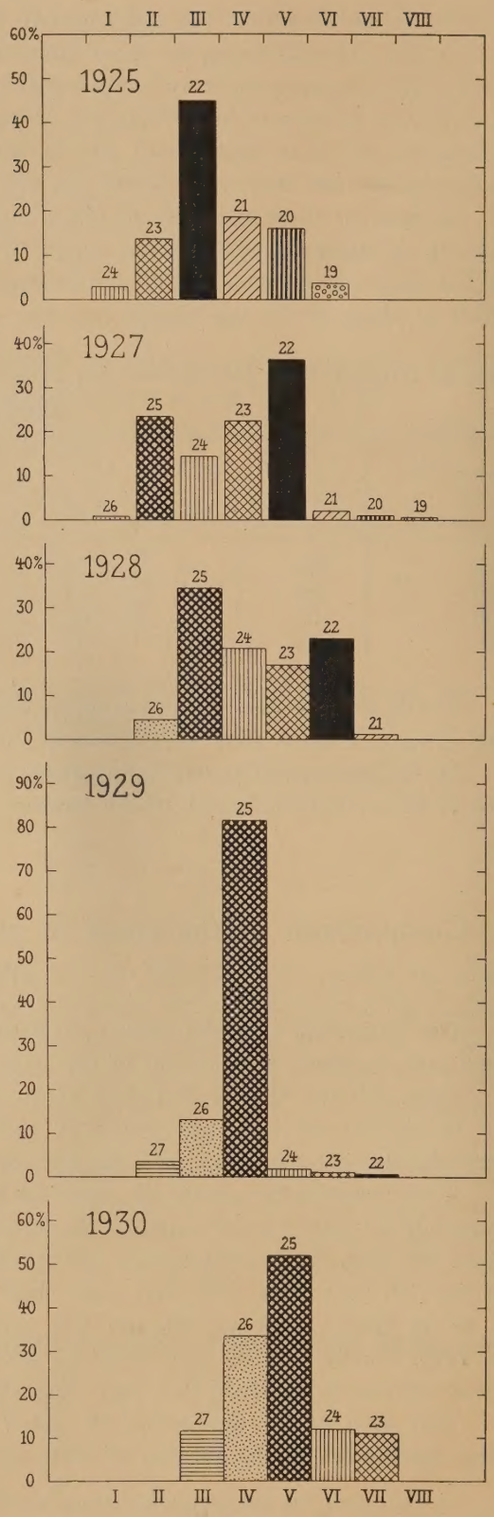

Fig. 4.

Fig. 4. Showing per cent. composition as to age groups in the southern Horns Reef Area in the springs of 1925, 1927, 1928, 1929 and 1930. The catches from 1925 and 1927 are taken by otter trawl, from the later years by Danish seine. The figures above the columns indicate year class.

of the same age group in the autumn of 1925, is undoubtedly due — particularly as regards group V principally to the increased average lengths (vide p. 13), which have resulted in a considerably larger number of plaice of these age groups being found beyond the 40 m. curve in 1930 than in 1925, but also to some extent to the increased intensity of the fishing which reduced the number of these age groups to a far greater extent in 1930 than in 1925. Year class 1926 must, however, certainly have been poorer than year class 1921, viz. below normal, as year class 1926 (the IV-group) could not have been so greatly reduced by emigration from the area and by the fishery that this could explain the great difference in quantity of the two year classes as found in age group IV.

A similar disappearance of the age group V, and older, was found by A. Bückmann on the west and east Frisian coasts in 1929 while that year this did not seem to be the case on the north Frisian coast[1].

By a comparison between the quantity of the age groups during the fishing experiments in 1930 and what was found during the experiments in the autumn of 1922 (vide Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. VIII. Nr. 6. 1928 table 8, p. 12) it will be seen that the year class 1927 was more or less of the same strength as year class 1919 which may be considered as being normal, and that year class 1928 was richer than year class 1920, which yielded above normal and also that year class 1929 was poorer than year class 1921 which was about a normally developed year class.

On examining samples of plaice caught, with a view to transplanting, from fishing cutters with a Danish seine, during April, in the southern Horns Reef Area at depths between 10 and 25 m. in 1928, 1929 and 1930, the number of plaice of the different age groups shown in table 7 were found.

Table 7. Percentage of plaice of the different age groups and total numbers caught with the Danish seine in the southern Horns Reef Area at depths between 10 and 25 metres in April of the years 1928, 1929 and 1930 (year class in brackets).

	II	III	IV	V	VI	VII	?	Total number
1928.....	4.3 (1926)	34.2 (1925)	20.7 (1924)	16.9 (1923)	23.0 (1922)	0.9 (1921)	0	439
1929.....	3.5 (1927)	13.1 (1926)	81.3 (1925)	1.6 (1924)	0.3 (1923)	0.1 (1922)	0	867
1930.....	—	11.4 (1927)	33.3 (1926)	51.4 (1925)	1.9 (1924)	1.0 (1923)	1.0	105

The reason why group II is not represented in the 1930 sample though it is derived from, as we have seen in the foregoing, the rich year class 1928, can be explained partly by the fact that that age group had particularly inferior average lengths, partly that the length of the smallest plaice examined in 1930 was 17 cm. whilst in 1928 and 1929 it was only 13 and 14 cm. respectively. The size of the meshes of the fishing gear is the cause of group II being so sparsely represented in 1928 to 1930 and also of a number of plaice of group III being absent from the samples.

Fig. 4 shows the per cent. composition, according to age groups, of plaice caught from the s.s. "Dana" with an ottertrawl with a fine meshed cod end, in the springs of 1925 and 1927 and the per cent. composition, according to age groups, found in the spring of 1928, 1929 and 1930 shown in table 7.

It will be seen that in 1928, year classes 1922—1925 comprised the most essential part of the stock examined. Year class 1925 was the predominating age group, but year class 1922 (age group VI) also constituted, by over 20 per cent., a considerable portion of the population.

In 1929, year class 1925 was what was principally found in the sample examined while year class 1922 had then, practically speaking, disappeared from the nursery grounds. Only year class 1926, with 13 per cent., is represented to a degree worth mention beside the year class 1925.

[1] A. Bückmann: l. cit. 1930 p. 45.

In 1930 year class 1925 likewise constituted the majority of the population but year classes 1926 and 1927, with an aggregate of 45 per cent., comprised a considerable portion of the population.

We get the following picture of the frequency of the different year classes in the southern Horns Reef area:—

Year class 1926..... below mean
— 1927..... mean
— 1928..... rich
— 1929..... poor.

The base for an investigation like this as to the relative frequency of the year classes is as A. Bückmann states[1] that the differences in the frequency of the year classes in the surveyed part of the nursery grounds in the southeastern Northsea is to a certain degree a constant feature. In the foregoing investigations nothing was found which could seem to contradict the named assumption.

There seems to be a rhytm of between 2 and 3 years in the frequency of the year classes, the rich year classes in the Horns Reef area being found in 1920, 1922, 1925 and 1928.

The same rhytmical intervals were found in the rapidity of growth at the marking experiments carried out in the area in 1903—1912. Maxima of growth were attained in 1905, 1907 and 1910—11[2] and this rhytm in the rapidity of growth must certainly be connected with the alternations in the frequency of the year classes so that it seems as if, also before the war, there was a rhythm of between 2 and 3 years in this frequency.

The result of the English and German investigations in this area[3], as regards the relative frequency of the age classes, confirms that of the Danish and in some instances provides a valuable supplement.

Thus it is interesting to observe that year class 1922, even as late as November 1928, was represented in the English catches by 18 per cent. of the examined samples at one of the stations ("Graadyb") and consequently, at that time was present in considerable quantities in the area. Furthermore it appears from the German fishing experiment at the station "Graadyb", in May 1929, that year class 1927 at that time was present in the catch to the extent of as many as about 1200 individuals in an hour's haul as compared with about 1600 individuals of year class 1925.

IV. Growth of the plaice.

In the tables after the commentary there is, for each station, shown the average length for the different age groups and in table 8, for each of the depth-zones concerned, the average lengths of the age groups within these areas have been reckoned[4].

Table 8. Average lengths of plaice of each of the age groups 0—V in the southern Horns Reef Area outside the 10 metre line, autumn 1930.

Depth-zone m.	0	I			II			III			IV			V		
	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀
10—20.....	7.0	10.9	11.4	11.2	13.2	13.4	13.3	20.4	20.7	20.6	22.0	23.8	23.1	27.3	27.5	27.5
20—30.....	—	12.7	12.2	12.5	14.9	15.1	15.0	21.9	22.6	22.2	25.1	24.7	24.9	26.5	29.1	27.8
30—40.....	—	15.2	15.2	15.2	17.2	17.2	17.2	22.6	23.0	22.8	25.2	26.4	25.9	28.5	28.7	28.6

[1] A. Bückmann: l. cit. 1930, p. 42—44.

[2] A. C. Johansen: Contributions to the Biology of the Plaice VII. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. IV. Nr. 9. 1915.

[3] W. Mielck: Southern North Sea. Rapports et Procès-Verbaux. Vol. LXVI. 1930, p. 141. — D. E. Thursby-Pelham: Fluctuations in the Age-Composition of the Plaice Stock in the Southern North Sea during the Period 1923 to 1928. Rapports et Procès-Verbaux. Vol. LXI. 1930, p. 76. — A. Bückmann: l. cit. 1930.

[4] All the lengths are reckoned to the nearest whole centimetre and 0.5 cm. must therefore be added to give the real lengths.

In Table 9 is shown the average length of the various age groups in April 1928, 1929 and 1930 in samples of plaice caught with the Danish seine from cutters in depths of from 10 to 25 m. In addition there is, in this table, shown average lengths of the various age groups determined by the quantitative fishing experiments from the s. s. "Dana" in the springs of 1925 and 1927. As, owing to the size of its meshes, the Danish seine has taken only the largest individuals of group II plaice, the average lengths found for this age group in April of the years 1928 and 1929 are much too large. Also as regards group III the average lengths in 1928—30 shown in Table 9 are a little too large, owing to the wide meshes of the implement used.

It is evident that the average length in each of the years 1928, 1929 and 1930, as is also found by the autumn fishing experiments in 1930, had on the whole increased but little since 1927.

Table 9. Average length of the different age groups in the springs of 1925, 1927, 1928, 1929 and 1930. The plaice is in the first named two years caught by 50 feet ottertrawl from "Dana", in the last named three years by Danish seine. (Numbers of plaice investigated indicated in brackets).

	I	II	III	IV	V	VI	VII
1925	8.3	12.9	16.3	21.3	23.5	25.5	—
1927	7.0	13.4	19.1	22.0	22.9	26.9	30.2
1928	—	17.1 (19)	20.5 (150)	22.6 (91)	24.1 (74)	24.9 (101)	25.8 (5)
1929	—	15.9 (30)	19.9 (114)	21.7 (705)	22.7 (14)	25.0 (3)	—
1930	—	—	19.3 (12)	22.7 (35)	24.1 (54)	23.0 (2)	25.0 (1)

Group V apparently had a far more vigorous increase of the average length from 1927 to 1928 than the other age groups, but this is explained by the fact that in 1927 age group V consisted of the rich and therefore slowly growing year class 1922 and in 1928 of the poorer, more rapidly growing year class 1923. Likewise the decrease in the average length found for group VI between 1927 and 1928 must be ascribed to the fact, that age group VI in 1927 consisted of year class 1921 whereas in 1928 it consisted of the rich year class 1922.

If the average length of the different age groups in the autumn, shown in table 8, be compared with the average lengths in that area before the war it will be seen that the plaice are still a deal smaller than they were before the war.

For the average length of the different age groups before the war can, according to A. C. Johansen[1], be estimated to have been as follows:—

The average length of the age groups 0—IV in 1905—09 in Sept.—March in the southern Horns Reef area at depths 5—24 m.

0-Group	7 — 8 cm.
I-Group	13 —14 —
II-Group	18.5—20 —
III-Group	24 —25.5 —
IV-Group	27 —30 —

In table 10 it has been reckoned how much larger or smaller the different age groups were in October 1930 than in October 1925.

[1] A. C. Johansen: Bericht über die dänischen Untersuchungen über die Schollenfischerei und den Schollenbestand etc. — Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. III. Nr. 8. 1910, pp. 74—76.

Table 10. Difference in average lengths in cms. for each age group 0—V between the autumn 1925 and the autumn 1930 in the different depth-zones.

Depth-zone m.	0-gr.	I-gr.			II-gr.			III-gr.			IV-gr.			V-gr.
	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂	♀	♂+♀	♂+♀
10—20.....	0.1	—1.8	—1.8	—1.7	—3.2	—3.3	—3.2	1.7	1.7	1.8	—0.4	0.8	0.4	1.8
20—30.....	—	—0.5	—0.8	—0.7	—1.6	—1.4	—1.5	2.7	3.5	3.1	1.5	—0.3	0.6	1.5
30—40.....	—	0.2	—	0.2	—0.9	—1.4	—1.1	2.4	2.2	2.4	1.4	2.2	2.0	3.0

It will be seen that while in 1930 the age groups I and II were about 1 and about 2 cm., respectively, smaller than the same age groups in 1925, the age groups III, IV and V were respectively about 2.5, about 1 and about 1.5 cm. greater than the corresponding age group in 1925.

This increased average length of the age groups III—V can only partly be ascribed to the increase of average length as a whole, as from table 10 it can be deduced that the average length of the age groups

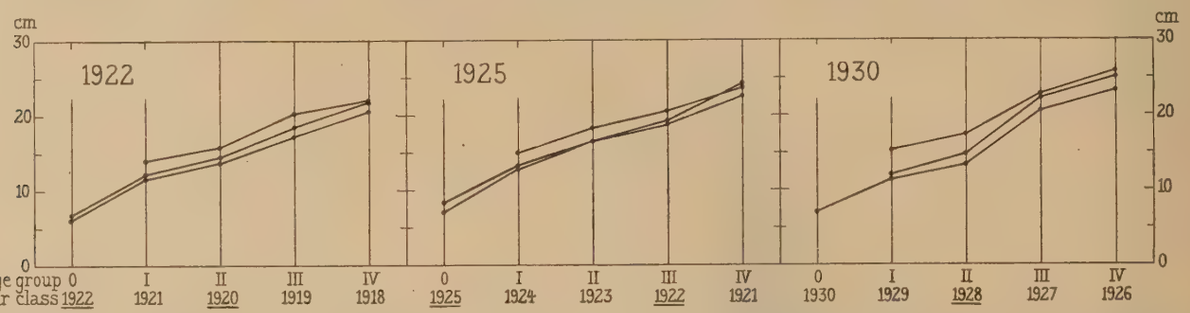

Fig. 5. Average lengths of the various age groups (year classes) in the southern Horns Reef Area, autumns 1922, 1925 and 1930 The nethermost lines indicate length in depth-zone 10—20 m., the middlemost lengths in depth-zone 20—30 m., and the uppermost lengths in depth-zone 30—40 m.

I—V in the area concerned, apart from the irregularities due to the difference between the frequency of the several year classes, was, on an average, only about $^1/_2$ cm. larger in 1930 than in 1925.

As was the case in the previous investigations in this area, the length of the individual age groups is influenced by the frequency of the year class that forms the age group in question. It is characteristic that the age groups I and II which showed smaller average lengths in 1930 than in 1925, consisted in 1930 of year classes 1929 and 1928 respectively, both of which were richer than the year classes (respectively 1924 and 1923) which in 1925 constituted age groups I and II, while on the contrary age groups III and IV, which showed greater average lengths in 1930 than in 1925, consisted of poorer year classes the first year than the last, as year class 1927 was poorer than year class 1922 and year class 1926 was poorer than year class 1921.

Fig. 5 shows the average length of age groups I—IV in the depth zones 10—20 m., 20—30 m. and 30—40 m. and it will be seen that the rich year classes 1920, 1922, 1925, and 1928 are distinguished by a comparatively inferior average length. It can be seen from the figure that each of these year classes has an average length of about 1 cm. below normal and that the average length of the poor year classes may to a similar extent be above normal. The same result that was apparent on comparing the average lengths of age groups in the spring of 1925 and 1927. (Medd. f. Komm. for Havunders. Ser. Fiskeri. Bd. VIII. Nr. 6. 1928, p. 23). Possibly this dependence between the frequency of a year class and its average length might be used as a criterion for the average length of an age group being determined with sufficient accuracy.

That age group V was so much larger in 1930, when it consisted of year class 1925, than in 1925, when it consisted of year class 1920, is presumably owing to the fact that the plaice of that age group, on account of the increased rapidity of growth, do not now, as far as the majority is concerned, belong to the nursery grounds but to the plaice stock of the open North Sea. Here as in the quite different nursery ground for plaice of the North Sea race, which is found in the northwestern Kattegat (the Aalbæk Bay—Herthas Flak Area) most of the plaice leave the nursery grounds when passing c. 26 cms. in length[1]. In the Aalbæk Bay—Herthas Flak Area this will be the case as III-gr., in the southern Horns Reef Area now as V-gr., in that the length of the V-gr. in April 1930 was 24.1 cm. and in October it was c. 28 cm. Also that diminution of the competition for food within the plaice stock of the V-group in the nursery grounds, which is due to the emigration of a considerable number of this plaice and to the effect of the fishery, will bring about a greater growth rate for the rest of this plaice.

V. The size composition of the population.

Table 11 shows the number and distribution of plaice above the Danish size limit for export plaice, 22.5 cm.[2], in October 1930 and table 12 the number and distribution of plaice above the size limit for

Table 11. Numbers (in brackets, percentage) of plaice over 22.5 cm.[3]) of the various age groups caught per hour in the southern Horns Reef Area between 10 and 40 metres depth, autumn 1930.

Depth-zone m.	II	III	IV	V	VI	VII	VIII	?	Total
10—20	0 (0)	6 (24)	3 (71)	6 (100)	—	0.3 (100)	—	2 (45)	17 (6)
20—30	0.4 (0)	27 (42)	16 (91)	14 (100)	—	—	0.4 (100)	2 (36)	59 (14)
30—40	2 (1)	52 (56)	9 (95)	6 (100)	—	—	—	2 (31)	72 (20)

plaice for the Danish market 25.7 cm. Here are shown partly the number of plaice of these sizes caught per hour and partly the percentage of the population they constitute, within the depth zone in question.

Table 12. Numbers (in brackets, percentage) of plaice over 25.7 cm.[4]) of the various age groups caught per hour in the southern Horns Reef Area between 10 and 40 metres depth, autumn 1930.

Depth-zone m.	II	III	IV	V	VI	VII	VIII	?	Total
10—20	0 (0)	0.3 (1)	0.3 (7)	5 (85)	—	0.3 (100)	—	0.7 (17)	6 (2)
20—30	0 (0)	3 (5)	7 (41)	11 (79)	—	—	0.4 (100)	0* (0)	22 (5)
30—40	1 (0.4)	8 (9)	6 (63)	6 (100)	—	—	—	2 (23)	24 (7)

By a comparison with the number of plaice, over 22.5 and 25.7 cm. in length, found in the autumn of 1925 (Medd. f. Komm. f. Havunders. Bd. VIII. Nr. 6. 1928, Table 32, p. 34 and Table 36, p. 36) it will be seen that the number of these plaice was somewhat less in 1930 than in 1925 but that the percentage of the population of the individual age group they formed, corresponding to the increased average lengths of age groups III—V, were larger in 1930 than in 1925.

[1] Aage J. C. Jensen: Investigations on the Stock of Plaice in the Kattegat and the Belts in the Years 1927—1929. — Rapports et Procès-Verbaux. Vol. LXXI. 1931, p. 16.

[2] The size limit, 22.5 cm., is in force from October 1st to February 28th (29th) for the rest of the year it is 24.0.

[3] In the table properly 23 cms. and above.

[4] In the table properly 26 cms. and above.

Of plaice over 30 cm. very many less were found in 1930 than in 1925, for while in the depth zones 10—20, 20—30 and 30—40 m., 1, 8 and 6 of this plaice, respectively, were taken per hour in 1925 the corresponding numbers in 1930 were 1, 1 and 1 respectively. As was the case in 1925 plaice over 33 cm. in length were very scarce. The fishing experiments in the area concerned in 1925 produced in all 2 (at depths of 25 and 32 m.) and in 1930 1 (at a depth of 24 m.).

VI. On the reasons for the increase in the yields of the Danish plaice fishery in recent years.

A. The yield of the fishery.

The annual yield of the Danish plaice fishery from Esbjerg has, since 1921, shown a great increase in weight, interrupted only by a slight falling off in 1927 (vide table 13).

Table 13. Yield of the Danish Plaice Fishery from Esbjerg (Sea fishery).

Year	Metric Tons	Year	Metric Tons	Year	Metric Tons
1900	1985	1910	4947	1920	3445
1901	2457	1911	4780	1921	1333
1902	4426	1912	7371	1922	2527
1903	2244	1913	6608	1923	3488
1904	3150	1914	4514	1924	3798
1905	3760	1915	9438	1925	9094
1906	2660	1916	3370	1926	9790
1907	4408	1917	1360	1927	7175
1908	2942	1918	2566	1928	12682
1909	3634	1919	4861	1929	15913

It will be seen from the table that the yield of the fishery not before the year 1925 reached a size which one could expect judging from the rather steady increasing yield in the years before the war.

Taking the average yield for five year periods we find:—

Period	Average Yield
1900—1904	2852 metric tons
1905—1909	3483 —
1910—1914	5644 —
.	.
1920—1924	2918 —
1925—1929	10931 —

This steady rise since 1921 is explained by two circumstances viz. the constant increase in the intensity of the fishing and, since 1922—23, an addition to the size of the plaice stock fished.

B. The dependence of the yield of the fishery on the composition of the stock.

In the preceding chapter it was pointed out that the number of plaice larger than 22.5 and 25.7 cm. had decreased since 1925. The same appears clear from table 14, where a comparison has been made of the total quantities of plaice of these sizes in the autumns of 1922, 1925 and 1930.

Table 14. Numbers of plaice above the Danish minimum limits for commercial plaice.

Depth-zone m.	Plaice > 22.5 cm.			Plaice > 25.7 cm.		
	1922	1925	1930	1922	1925	1930
10—20	4	24	17	1	10	6
20—30	7	142	59	1	60	22
30—40	22	136	72	6	49	24
> 40	15	44	?	4	31	?

The number of plaice over 30 cm. had likewise decreased since 1925.

From table 14 it will be seen that the population of plaice of these categories is only slightly less than half as large as in 1925 but is still far larger than in 1922.

That the average length, as a whole, has not increased more than about $^1/_2$ cm. suggests that the aggregate density of the population during growth has not been much less than it was for the population found in 1925.

This is apparently at variance with the above ascertained decrease in the number of plaice, but here two circumstances must be borne in mind firstly the effect of the fishery, secondly the effect of the increased growth rate. What is ascertained by the fishing experiments in respect of commercial plaice, is only a remnant population as the fisheries have removed a considerable deal of these plaice. In a series of years when the fishery has been carried on at a uniform rate year after year this is of no consequence, when it is a question of comparing the value of the stock for the fishery for two years, but within a series of years, like that considered here, when the intensity of the fishing has been increasing year after year (vide below) this must be taken into account. If for instance, the fishery takes 40 % annually it reduces a stock of 100 commercial plaice to 36 in the course of two years; whereas if it takes 60 % annually it reduces a stock of 100 commercial plaice to 16 in the course of two years fishing.

Also it must be remembered that the V-group in 1930, though arising from the rich year class 1925, was to be found on the nursery grounds in but small numbers, which was essentially to be explained by a very considerable number of this plaice having emigrated from the area out into deeper water where the growth rate is more rapid.

All in all the steady increasing growth rate will cause the stock of plaice at the boundary between the nursery grounds and the open Northsea, where a considerable part of the Danish plaice fishery goes on, to be recruited year by year by still younger age groups, i. e. by steady increasing numbers. The size limits for commercial plaice at present is passed at a younger age now than formerly.

In what way the alternations in the frequency of the year classes affect the yield, cannot yet be determined with certainty, as it has not yet been quite decided whether a rich year class, by the decrease of the growth-rapidity it effects, will diminish the weight yield of the fishery some years later (and, subsequent to that, contingently increase the yield of the fishery in the years that follow, when its plaice have grown to be commercial plaice) or whether it will merely effect an increased weight yield of the fishery after the expery of some years.

From the English investigations of Trade category samples it seems to appear that it is groups IV and V that have the most significant effect on the yield of the English fishery[1]. As regards the Danish fishery where, unfortunately, investigations of Trade category samples are not made, whether it is reckoned that here also it is, as groups IV and V, or as group IV, a particular year class has the most significant effect on the size of the catch, one cannot alone from the consideration of the alternations in the frequency of the year classes find an explanation for the alternations in the yield of the fishery in recent years and more particularly is the increase in the yield of the fisheries unexplainable in that way alone.

[1] D. E. Thursby-Pelham l. cit. 1930, p. 81.

C. Dependance of the yield of the fishery on the alteration of fishing methods.

Of late years the trawl fishery for plaice in the North Sea, and particularly the English trawl fishery, has declined seriously, while the Dutch, and particularly the Danish, cutter fishery has developed very considerably.

KYLE and EHRENBAUM have called attention to this alteration and to the very important fact that it must effect a substantial sparing of the stock of small plaice at the nursery grounds and they have furthermore indicated that the alteration is undoubtedly the reason why the rapidity of growth has not yet reached what it was before the war. In regard to this they write:

"Es ist ganz überzeugend erwiesen, dass eine Schonung auf die Geschwindigkeit des Wachstums zurückwirkt. Man kann auch annehmen, dass die Sterblichkeit in den ersten Jahren sehr beträchtlich sein muss — und gerade infolge von Nahrungsmangel, weil, soviel wir wissen, die Schollen nach dem ersten Lebensjahr, nur wenig Feinde haben. Der Hauptgrund für diese Sterblichkeit liegt aller Wahrscheinlichkeit nach in der Konkurrenz".[1]

While these authors, in this repression of growth, are inclined to see a danger to the fishery, A. C. JOHANSEN has advanced the opinion that "this development of the plaice fishery, which has occurred in recent years, seems to have induced an increased production of small and medium plaice in the eastern part of the North Sea, from about a depth of 10—40 metres. The weight-yield of the Danish plaice fishery in these areas was greater in 1925 to 1929 than it had ever been before".[2]

We shall therefore in the following go more closely into the development of the fishery and investigate what consequences it may have had on the stock of plaice.

Development of the fishery in the southern North Sea.

The trawl fishery. The stock of large plaice in the open North Sea which accumulated during the blockade of the sea with mines was the occasion for the trawl fishery being carried on principally in this area in the years immediately after the war, but gradually as these plaice were fished up the fishery was moved more and more towards the young plaice nursery grounds of the North Sea.

If we consider the southern Horns Reef area between the 10 m. curve and 6° E. Long. the English trawlers carried on their fishing in each carre (each carre from North to South is half a degree of latitude and from East to West one degree of longitude) as follows:[3]

1920: during 1 000 hours.
1921: about something between 1 000 and 5 000 hours.
1922: between 10 and 30 m. depths for 10 000—25 000 hours, in greater depths for about 5 000 hours.
1923: for 10 000—25 000 hours in still larger areas than in 1922.
1924: for about the same as in 1923.
1925: for 5 000—10 000 hours between 10 and 30 m. depths, in greater depths for 1 000—5 000 hours.

The Cutter fishery. The yield of the Danish cutter fishery for plaice from Esbjerg for the several months of the year is shown in the table below.

[1] H. M. KYLE und E. EHRENBAUM: Wandlungen in der Schollenfischerei der Nordsee und ihre Folgen. Der Fischerbote. Hft. 2. 1930.

[2] A. C. JOHANSEN: Memorandum on the Progress in the Researches in relation to Practical Fishery Problems in the North Sea. — Rapports to the international Council for the Exploration of the Sea, 1930 here cited with kind permission of Dr. A. C. JOHANSEN.

[3] J. O. BORLEY and D. E. THURSBY-PELHAM: Report on the English Plaice Investigations in the North Sea during the years 1921—1923. Fishery Investigations. Ser. II. Vol. VII. No. 6. 1925 and D. E. THURSBY-PELHAM: Report on English Plaice Investigations 1924 and 1925. Fishery Investigations. Ser. II. Vol. X. No. 3. 1928.

Table 15. Monthly distribution of the weight yield of the Danish cutter plaice fishery from Esbjerg.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1920—24	1	1	6	15	17	13	10	14	10	9	3	2
1925—29	0.5	1	9	11	16	12	12	13	11	8	5	2

The most important cutter fishery for plaice occurs, according to the above, in March to October.

The intensity with which the cutter fishery is carried on may to a certain extent be estimated by the number of cutter days i. e. the number of cutters which have carried on fishery multiplied by the number of fishing days. This number has increased greatly in the course of the period 1920—1929 (vide table 16).

Table 16. Average monthly number of cutter days in March—October.

Year	Number of cutter days	Year	Number of cutter days
1920	3670	1925	6333
1921	3294	1926	5878
1922	3373	1927	5525
1923	3683	1928	6687
1924	3995	1929	6237

As the plaice fishery is the most essential of the cutter fisheries carried on from Esbjerg during these months, the increase to be seen in the number of cutter days within this series of years shows that the intensity of the plaice fishery with the Danish seine has increased very greatly during this period. The average monthly number of cutter days was as follows:

1920—24	3603
1925—29	6110

The increase in the intensity of the plaice fishery with the Danish seine from Esbjerg has in reality been considerably greater than it appears from the above investigation of the number of the cutter days.

The Danish cutter fishery in the North Sea is divided between plaice and haddock fishing, so that the one that, for the time being, pays best attracts fishers from the other, but no statistical information is available as to how large a portion of the cutter fleet has been engaged in one or the other of these fisheries. During recent years the pecuniary results of the haddock fishery have been worse than those of the plaice fishery, partly because the quantity yielded per fishing unit, which culminated in 1926, has since that year decreased[1] and partly on account of a decline in prices. Fishers have therefore gone over from the haddock to the plaice fishery. In the annual Danish fishery statistics[2] the following statement appears regarding the haddock fishery from Esbjerg:

For 1923: "Fishing for haddock was carried on most energetically from Esbjerg. The yield did ... not quite correspond with the energy expended".

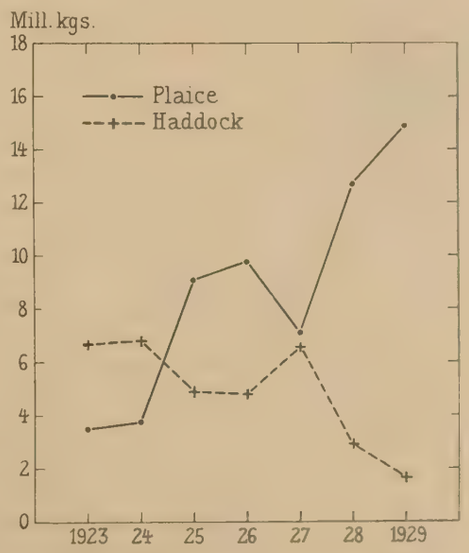

Fig. 6. Yield of the plaice and haddock fisheries landed in Esbjerg from the Danish sea fishery in the years 1923—1929.

[1] Harold Thompson: Fluctuations in the North Sea Haddock Stock. Rapports et Procès-Verbaux. Vol. XLV. 1930, p. 37.

[2] F. V. Mortensen: Fiskeri-Beretning 1924—30.

For 1925: "There was certainly a fairly large stock of haddock present but composed, for the most part, of younger age groups ... for that reason many of our North sea fishing craft preferred fishing for plaice".

For 1929: "As regards the Esbjerg fishery, the decline in the yield (in the haddock fishery) must chiefly be ascribed to the continuous and rigorous participation of the fishing craft in the plaice fishery".

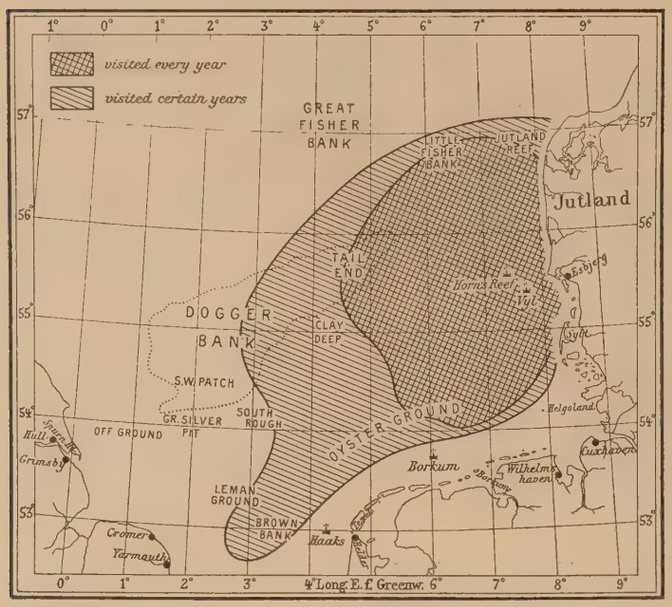

Fig. 7. Fishing grounds for the plaice fishery with the Danish seine from Esbjerg.

The yield of the two fisheries, on account of this interaction, shows a pronounced negative correlation, such as it appears from Fig. 6.

The area in which the Danish plaice fishery from cutters fishing from Esbjerg was carried on during the period 1925—1930 is shown on Fig. 7. This chart has been drawn up on the base of the monthly reports on the fishery to the fishery directorate, kindly placed at my disposal by the fishery director F. V. Mortensen.

Consequently the changes in the intensity of the fishery are that the trawl-fishery during 1920—24 was year by year carried on more vigorously at the nursery grounds in the Horns Reef area but declined in intensity after that time, while the cutter fishery with the Danish seine has since 1925 increased very much.

The change in the methods of the fishery is doubtless the reason why the increase in the average length of the different age groups at the nursery grounds in south-eastern North Sea found from year to year from 1922 to 1925[1] practically ceased after the above mentioned change in the fishery took place. In the years 1925—30 the average length of the age-groups was only increased by, in all about $^1/_2$ cm. (cp. p. 12). An exactly similar stoppage in the increase of the lengths of the different age groups from year to year is recorded by A. Bückmann for the area around Helgoland.[2]

It is mentioned above (p. 15) that the increased intensity of the cutter fishery must have contributed to diminish the number of plaice above the Danish minimum size found in the fishing experiments.

As the trawl fishery has since 1924—25 been greatly reduced and replaced by the cutter fishery with the Danish seine, so sparing as regards the stock of young fish, the undersized fish have, on the other hand, been spared. The aggregate density of the stock has therefore remained almost the same (p. 15) and the rapidity of growth has remained practically unaltered. Thus there is now produced a, in relation to the production of young plaice, larger stock of undersized fish, which can serve to recruit the commercial plaice, than before the change in the methods of fishing.

Thus A. C. Johansen — provided that a continued increase of growth, brought about by a thinning out of the stock, does not give an increased production of commercial plaice — is undoubtedly right in the above (p. 16) quoted opinion that the change in the method of fishing has meant an advantage to the fishery.

[1] Aage J. C. Jensen: l. cit. 1928 p. 42.

[2] A. Bückmann: l. cit. 1930 p. 52.

The development of the plaice fishery in the waters inside Skagen and the results of the fishery investigations offer an important material for an investigation of what effects a change in growth would have on the plaice fishery.

D. The influence of the rapidity of growth on the yield of the fisheries.

1. Transition Area.

Kyle and Ehrenbaum have referred to the importance of the rapidity of growth for the development of the plaice fishery in the Kattegat, the Belt Sea and the Baltic.

Particularly in the Belt Sea and the Baltic has the rapidity of growth, owing to the thinning out of the stock caused by the fishery, been greatly increased and at the same time the yield of the fishery for a series of years has been growing much larger.

It must however be remembered that the reason why the yield of the fisheries could be so greatly increased when the intensive fishing set in was that, at that time, there was an accumulated stock of plaice which, owing to its density, was so slow in growing that but few reached beyond the minimum size for commercial plaice (25.6 cm.). When the intensive fishery with the Danish seine and otter seine set in, as regards the Belt Sea in 1910 and immediately after the war and as regards the Baltic in 1922, the stock was at once thinned out so much that the growth was increased and the many undersized fish were able to grow up over the minimum size.

When the accumulated stock of undersized fish had, after a few years, grown to be commercial plaice and fished away, so that the fishery was carried on essentially on a single year class, the fishery was ruined, as the yearly recruiting, in spite of the growth of the 20—25 cm. Belt Sea plaice being now about 8 cm. in the first year, could not outweigh what the fishery removed annually, and the quantity of plaice fished has therefore diminished year by year[2].

In the Kattegat the stock in the commercial plaice areas in the eastern and southern parts has gradually been thinned out and the average length of the II-group is now larger in that area than the IV-group was in 1905—07[3]. The fishery yield has decreased correspondingly[4].

In none of these places, therefore, has constant increase of the yield been attained by so thinning out the stock that the rapidity of growth has become greater. There is no doubt that a virgin stock, like that found in the Belt Sea previous to about 1910 and in the Baltic until after the war, is improved by fishery, but the intensity of the fishing, that has produced a material increase of growth, has been so great that the recruiting of the stock has not been able to bear the decimation which the fishery brougth about.

It migth be supposed that the violent fall in the yield of the plaice fishery in the Belt Sea and the Baltic was due to the stock of spawning plaice being deciminated too rigourously by the fishery[5]. A. C. Johansen has pointed out that it is fairly probable that as regards the Belt Sea and the southern Kattegat some decrease can be perceived in the production of the young bottom stages of plaice[6]. If we reckon the average number of 0- and I-groups caught per hour in the fishing experiments at the coasts we get:—

[1] H. M. Kyle: l. cit. 1928 p. 34 ff. and H. M. Kyle und E. Ehrenbaum: l. cit. 1930.

[2] C. G. Joh. Petersen: On the stock of Plaice in relation to the intensive fishing of the present time in the Belt Sea and other waters. Report of the Danish Biol. Stat. XXVII. 1921. — H. Blegvad: On the Renewal of the Stock of Plaice in the Baltic proper. Report Danish Biol. Stat. Vol. XXXII. 1927. — Reports of K. A. Andersson and Arvid R. Molander, H. Blegvad, A. C. Johansen and S. Strodtmann in Report of the Transition Area and Baltic Area Committees concerning the Question of Protection of Plaice etc. Rapports et Procès-Verbaux. Vol. XLVIII. 1928.

[3] Aage J. C. Jensen: l. cit. 1931 p. 38.

[4] A. C. Johansen: On the Decrease in the Yield of the Plaice Fishery in the Kattegat and Skagerak in the last Decennaries and Cause of the same. — Rapport et Procès-Verbaux. Vol. LXXI. 1931.

[5] sml. H. M. Kyle l. cit. 1928. p. 36.

[6] A. C. Johansen: l. cit. 1931. p. 118.

	0-Gr.	I-Gr.
1905—14	16.7	6.1
1926—30	13.4	5.2

The average catch per hour for 0-Gr. and I-Gr. in the period 1920—30 was 16.7 and 5.2 respectively. Although under similar conditions more plaice were, perhaps caught during late years than earlier on account of the fishing during the fishing experiments being, after a time, carried on for a little more extensively at places where from experience the young plaice were known to be most numerous, the difference is, however, too slight to admit of the decrease found being considered the cause of the catastrofic falling off in the yield of the plaice fishery. This, in the Belt Sea, had in 1926 sunk to less than 1.7 mill. kg. that is to say half the average of the rich years 1918—1922, and has since steadily decreased.

Only in the most recent years the production of young plaice seems to have decreased as much as largely affecting the yield of the fishery. The fact is that the catch of 0-group plaice was very low in each of the years 1928, 1929 and 1930, namely 8.5, 5.4 and 5.5 per hour respectively, in the named area.

A material improvement in growth, brought about by thinning out the stock by means of intensive fishery in all these areas where food conditions for the plaice are without doubt considerably better as a rule than in the North Sea, has as we have seen been attained only at the cost of the marketable value.

Though the number of young plaice is greater in the North Sea in proportion to the present state of the fishing intensity, than is the case in the waters inside Skagen, it is therefore not probable that the development of the stock in the North Sea with a very much increasing fishing intensity, i. e. with a more decisive thinning out of the stock of young plaice at the nursery grounds, will be better than it has been in the Kattegat, Belt Sea and Baltic.

2. The North Sea.

a. The influence of growth on the yield of the fishery. The earlier Danish investigations in the Horns Reef area present a material for a direct investigation of how changes in the rapidity of growth affect the yield of the plaice fishery in the North Sea.

The annual growth of plaice varies normally in the Horns Reef area greatly from year to year. The Danish marking experiments in 1903—1912[1] show that in the case of the plaice marked in these years it varied between 3.1 cm. in 1909 and 7.9 cm. in 1905, while the annual average growth was 5.2 cm.

The divergences were therefore from 40 % below to 52 % above the average growth.

With the same number of plaice at a certain length interval below the lower limit for commercial plaice, the recruiting of the latter would vary from year to year in a similar manner and the least yield could be expected in the years the growth was slightest. The assumption regarding the same number of undersized fish does not, however, hold good, as the slight growth is generally occasioned by a dense stock. The changes in the quantity of fish would thus counteract the effect of the growth changes on the yield of the fishery.

In the years 1904—1908 the growth was steadily over 5 cm. annually (average 6.5 cm.) and in 1909—1912 it was steadily below 5 cm. (average 3.9).

The average yield of the Danish plaice fishery from Esbjerg per cutter day[2] was for the first period 158 kg., in the second period 149 kg. It appears that the difference between the yield of the two periods was so slight that it might be concluded that the growth is not of a decisive significance for the size of the yield.

As a standard for the yield of the fishery I have employed the yield per cutter day and shall not discuss the propriety of so doing but will merely mention that the difficulties attached to the use of this

[1] A. C. Johansen: Marking Experiments with Plaice in the North Sea off the West Coast off Jutland, during the Years 1906—1912. Medd. f. Komm. f. Havunders. Ser. Fiskeri. Bd. IV. Nr. 9. 1915.

[2] I. e. for a cutter per fishing day.

standard as an expression for the size of the stock in which the fishery is being carried on, which KYLE maintains[1], will not affect its use here[2].

Another method of investigation as to whether there exists a connection between rapidity of growth and the catch is to correlate growth and yield of the fishery.

A calculation of the coefficient of correlation between growth of plaice and weight yield of the Danish plaice fishery landed at Esbjerg gives, when the annual growth is correlated with the weight yield the same year: $r = 0.40$; $\sigma_r = 0.27$, and when the growth is correlated with the weight yield next year: $r = -0.63$; $\sigma_r = 0.19$.

The result of the last calculation migth seem to indicate that great growth one year, that is to say, slight density of plaice, gives a small yield of the fishery the following year, when a considerable number of these plaice have grown to be commercial plaice. Such a conclusion is however, quite inadmissible, as the size of the correlation must principally be ascribed to the fact that the weight-yield of the fishery generally has been increasing from year to year owing to the increasing intensity of the fishery, while the rapidity of growth on the contrary has been greater in the first part of the years under consideration than in the last.

If the catch per cutter day be used as an expression for the yield of the fishery, this measure being directly dependent alone on the quantity of commercial plaice at the disposal of the fishery, we get:

Annual growth of plaice correlated with	catch per cutter day the same year	$r = 0.31$; $\sigma_r = 0.28$
	catch per cutter day next year	$r = -0.41$; $\sigma_r = 0.26$

The period for which it has been possible to make the calculation is 10 years, consequently too short a time to ascertain with certainty whether a dependence can be shown but the result of the calculation shows for certain that in any case there is only a slight dependence between rapidity of growth and catch.

b. Nutrition conditions in the North Sea. The valuation investigations are of considerable interest in determining the nutrition conditions of the plaice stock as HAGMEIER[3] seems to have been able to trace a connection between the extent of the growth of plaice and the quantity of the nutritive animals on a basis of the investigations off the East Frisian coast which unfortunately, have extended over so very few years.

As far as the valuation investigations show, the nutrition conditions for plaice in the south eastern areas of the North Sea seem to be rather unfavourable. Particularly the sand grounds (the *Venus gallina* community) are, in conformity with the turbulent state of the bottom, rather thinly inhabited though in certain years a dense stock of a single species is to be found in patches[4]. It seems, therefore, unreasonable to suppose that the growth of the plaice, except by an excessive thinning of the stock, can be increased very materially.

It is characteristic, that the great growth rate, 11—12 cm., in the first year of plaice of c. 20 cm. length which is stated by marking experiments on the Dogger Bank[5], are found jointly with a very thin population.

[1] H. M. KYLE: Die Statistik der Seefischerei Nordeuropas. — Handbuch der Seefischerei Nordeuropas Bd. X. Hft. 4. Stuttgart. 1928 p. 24.

[2] cp. E. S. RUSSELL: Some theoretical Considerations on the "Overfishing" Problem. — Journal du Conseil. Vol. VI. No. 1. 1931 p. 12 ff.

[3] A. HAGMEIER: Eine Fluctuation von *Mactra (Spisula) subtruncata* (da Costa) an der ostfriesischen Küste. — Berichte der Deutschen Wissenschaftl. Komm. f. Meeresforsch. N. F. Bd. V. Hft. 3. 1930.

[4] A. HAGMEIER: Vorlaufiger Bericht über die vorbereitenden Untersuchungen der Bodenfauna der Deutschen Bucht mit dem Petersen-Bodengreifer — Bericht der Deutschen Wissenschaftl. Komm. f. Meeresforsch. N. F. Bd. I. Nr. VIII. 1925 p. 265.

[5] J. N. CARRUTHERS: Report on the English Post-War Plaice Marking and Transplantation Experiments. Fishery Investigations. Ser. II. Vol. VI. No. 5. 1924.

A thinning out of the young plaice stock in the North Sea nursery grounds to such an extent as to obtain there a greatly increased rapidity of growth, would not therefore give a favourable result for the commercial value of the stock of plaice.

E. The causes for the increase in the yield of the Danish plaice fishery in the North Sea.

As it appears from the foregoing, a great increase in the intensity of the fishery has taken place since 1925.

It is now a question as to what part the changes in the plaice stock of recent years play in this increase and in the increase in the yield.

From 1892 to 1914 the weigth-yield of the Danish plaice fishery in the North Sea increased fairly evenly at an average of 7.3 % annually on account of the steadily increasing intensity of the fishing and there is therefore reason to expect that in recent years it may also show a similar annual increase on account of the natural extension of the fishery.

The question whether the increase in the intensity of the fishery is due also to changes in the pecuniary profit is very complex as this is dependent partly on the gross earnings of the fishery which are determined both by the price per kg. of fish and by the catch per fishing unit, and partly on the working expenses.

First we will consider the price.

The price obtained for the plaice has on the whole been decreasing since 1925 both absolutely and seen in relation to the price level. If we take the price for plaice in Esbjerg in 1920 reckoned in relation to the retail price index calculated by the ministerial statistical department as 100 we get the following figures for the price in the years 1920—29 in relation to the price level (retail price index):

year	price relative to price index	year	price relative to price index
1920	100	1925	91
1921	98	1926	83
1922	100	1927	77
1923	117	1928	78
1924	124	1929	72

We ascertain from this that the variations from year to year in the price obtained is opposite to the variations in the yield of the fishery which we can take as an indication for that it is not the price which has stimulated the fishery to the great increase, but that, on the contrary, it is the yield of the fishery which has regulated the prices.

If we turn to the working expenses of the cutters, we will find that the cost of fuel oil is the principal item, constituting at it does more than a third of the total working expences[1].

The price of this and the retail price index has varied as follows:—[2].

Year	Average price, Oere crude oil ("Alfa" oil)	Average price, Oere motor petroleum	Retail price index	Year	Average price, Oere crude oil ("Alfa" oil)	Average price, Oere motor petroleum	Retail price index
1920	49.2	—	261	1925	14.6	18.3	211
1921	27.3	31.5	232	1926	12.5	17.0	184
1922	14.1	19.6	200	1927	12.8	16.0	177
1923	13.0	17.0	206	1928	11.6	14.0	175
1924	15.9	19.1	216	1929	10.7	14.8	173

[1] I. A. v. Deurs, Aage J. C. Jensen og Albert Larsen: Haandbog i Havbrug I: Havbrugets Økonomi. Copenhagen 1930. p. 61.

[2] The figures are calculated on a basis of the information most kindly given to me by "Det danske Petroleums A. S.", Copenhagen.

It will be observed that since 1925 there has been a fall in price greater than the fall in the retail price index. This in connection with the fact that crude oil motors have been more common in the course of the recent years helps to explain the increase in the intensity of the fishery.

On the other hand most of the other working expences, for instance, the expences for fishing implements have remained fairly constant since 1923.

Besides the yielding capacity of the haddock fishery as mentioned p. 17 has certainly contributed to increase the intensity of the plaice fishery.

I have previously pointed out that the most essential factor contributing to the increased yield of the plaice fishery since 1925 was the great improvement, from a commercial point of wiew, that had taken place in the stock partly on account of richer year classes now constituting the stock of plaice above the Danish minimum limit and partly because the rapidity of growth had greatly increased[1]). That this, however, has not been the principal cause for the increasing cutter fishery during the years 1925—1930 is evident from the fact that the quantity of both large undersized fish and of commercial fish has been somewhat less since 1925.

Yet the biological changes of the plaice stock brought about by the changes in fishing methods from otter trawl to Danish seine have meant a benefit to the fishery so that partly the yield of the fishery per fishing unit has become comparably larger, partly the intensity of the fishery has been stimulated by the plaice stock being more productive than would be the case during otter trawl fishery.

There seems to be nothing disadvantageous in the rapidity of growth not having increased more than $^1/_2$ cm. in the last five years. The yield of the fishery becomes, of course, more uniform year by year when the stock of commercial plaice does not, as in the Belt Sea, consist of a single year class but is recruited from a series of year classes.

An intensive seine fishery which removes the larger plaice almost as quickly as they pass the size limit for commercial plaice, can have just as alleviating an effect on the competition between the undersized plaice as a trawl fishery for, as is well known, the larger plaice require comparatively larger quantities of nutriment than the smaller ones,

With an increasing intensity of the seine fishery for plaice it must consequently be expected that the rapidity will be somewhat increased but it is very unlikely that the rapidity of growth can be increased very materially without so rigorous a decimating of the stock that it decreases its productivity.

A protection of the young plaice nursery grounds in the south eastern North Sea similar to what was proposed by the Plaice Committee set down by the *Conseil international pour l'exploration de la mer*[2] has, to all intents, now been carried out as regards the Horns Reef area by the change to which the fishing methods have been subjected, and the result is to the benefit of the future of the plaice fishery in the North Sea, as the rapidity of growth at the nursery grounds has not been diminished but on the contrary, increased slightly, and the stock of young plaice is spared, so that a comparatively greater number of plaice of one year class can grow up to be commercial plaice than formerly.

It is furthermore of interest that the fishery showing the greatest increase in its yield, is the Danish, for which a high minimum has been fixed and where the fish are taken on board alive, so that undersized fish can be thrown back alive. This protective fishery which is so sparing for the stock seems, consequently, to be the most remunerative.

[1] Aage J. C. Jensen: l. cit. 1928. p. 37.

[2] Rapports et Procès-Verbaux Vol. XXVII. 1921. p. 50.

Tables.

Results of analyses for age groups, sex, and length.

At three stations (4335, 4337, and 4341) only a representative part of the catches taken in the trawl has been analysed for age groups. All plaice caught in the extra codend are analysed. In the tables in the columns for distribution as to lengths of the different age groups are only given the part of the catch, which had been analysed.

At the right hand side of these three Tables are given the total numbers caught distributed as to length, and below the figures for the total number of plaice analysed for age groups are given the calculated total numbers of plaice of each age group.

Stat. 4328. — Oct. 23rd, 1930. — 55° 27′ N. Lat. 8° 11′ E. Long. Depth: 11 m. — Duration of fishing: 30 minutes.

Age group	0	I		II		III		IV		V	?		Total
Sex	♂ + ♀	♂	♀	♂	♀	♂	♀	♂	♀	♀	♂	♀	♂ + ♀
Length cm.													
6	4	..	..	..	..	..	..	..	..	..	..	..	4
7	3	..	..	..	..	..	..	..	..	..	..	..	3
8	1	1	..	..	..	..	..	..	..	..	..	..	2
9	2	8	2	..	..	..	..	..	..	..	..	..	12
10	..	17	23	4	4	..	..	..	..	..	..	..	48
11	..	27	24	14	13	..	..	..	..	..	..	..	78
12	..	22	26	34	32	..	..	..	..	..	1	1	116
13	..	11	10	37	31	..	..	..	..	..	1	2	92
14	..	1	4	21	24	..	..	..	..	..	1	..	51
15	..	..	2	11	14	..	..	..	..	..	..	..	27
16	..	..	1	5	10	..	1	..	..	..	..	..	17
17	..	..	..	1	1	..	2	..	..	..	..	..	4
18	..	..	..	..	1	2	7	..	..	..	..	..	10
19	..	..	..	3	1	2	5	1	..	..	..	..	12
20	..	..	..	..	..	2	4	..	..	..	..	..	6
21	..	..	..	3	2	1	7	1	1	..	..	..	15
22	..	..	..	..	..	1	4	..	..	..	..	..	5
23	..	..	..	..	..	..	1	..	..	..	..	1	2
24	..	..	..	..	..	..	1	..	..	..	..	..	1
25	..	..	..	..	..	..	..	..	1	1	..	..	2
26	..	..	..	..	..	..	1	..	..	1	1	..	3
Total	10	87	92	133	133	8	33	2	2	2	4	4	510
Average length ♂ and ♀	..	11.1	11.5	13.2	13.3	19.6	20.0	20.0	23.0	25.5	26.0	23.0	..
— — ♂ + ♀	7.0	11.3		13.2		19.9		21.5		25.5	24.5		..

Stat. 4329. — Oct. 23rd, 1930. — 55° 27′ N. Lat. 8° 00′ E. Long. Depth: 14 m. — Duration of fishing: 30 minutes.

Age groups	0	I		II		III	IV	Total
Sex	♂ + ♀	♂	♀	♂	♀	♀	♂	♂ + ♀
Length cm.								
7	1	..	..	..	..	..	..	1
8	..	..	..	..	..	..	..	..
9	1	..	..	..	..	..	..	1
10	..	2	..	..	..	..	..	2
11	..	2	..	1	..	..	..	3
12	..	3	4	4	1	..	..	12
13	..	..	3	2	3	..	..	8
14	..	..	..	2	2	..	..	4
15	..	..	..	..	1	..	..	1
16	..	..	..	1	..	..	..	1
17	..	..	..	..	..	..	..	..
18	..	..	..	..	..	2	..	2
19	..	..	..	..	..	..	..	..
20	..	..	..	..	..	..	..	..
21	..	..	..	..	..	..	1	1
22	..	..	..	..	..	..	..	..
23	..	..	..	..	..	1	..	1
Total	2	7	7	10	7	3	1	37
Average length ♂ and ♀	..	11.1	12.4	12.9	13.4	19.7	21.0	..
— — ♂ + ♀	8.0	11.8		13.1		19.7	21.0	..

Stat. 4330. — Oct. 23rd, 1930. — 55° 20′ N. Lat. 8° 00′ E. Long. Depth: 17 m. — Duration of fishing: 60 minutes.

Age group	I		II		III		IV	V		Total
Sex	♂	♀	♂	♀	♂	♀	♂+♀	♂	♀	♂+♀
Length cm.										
9	1	..	..	..	..	..	..	..	..	1
10	1	..	..	..	..	..	..	..	..	1
11	..	1	..	..	..	..	..	..	..	1
:	..	..	..	..	..	..	..	..	..	..
15	..	..	1	..	..	..	..	..	..	1
16	..	..	..	2	..	..	..	..	..	2
:	..	..	..	..	..	..	..	..	..	..
19	..	..	..	..	1	..	..	..	..	1
:	..	..	..	..	..	..	..	..	..	..
23	..	..	..	..	..	..	..	1	..	1
24	..	.	..	..	..	..	..	..	..	..
25	..	..	..	..	..	1	..	..	..	1
:	..	..	..	..	..	..	..	..	..	..
30	..	..	..	..	..	..	..	..	1	1
Total	2	1	1	2	1	1	..	1	1	10
Average length ♂ and ♀	9.5	11.0	15.0	16.0	19.0	25.0	..	23.0	30.0	..
— — ♂+♀	10.0		15.7		22.0		..	26.5		..

Stat. 4331. — Oct. 24th, 1930. — 55° 20′ N. Lat. 8° 13′ E. Long. Depth: 14 m. — Duration of fishing: 30 minutes.

Age group	0	I		II		III	Total
Sex	♂+♀	♂	♀	♂	♀	♂	♂+♀
Length cm.							
6	1	..	..	..	..	..	1
7	2	..	..	..	..	..	2
8	..	..	..	..	..	..	..
9	..	5	1	..	..	..	6
10	..	4	3	..	..	..	7
11	..	1	1	1	..	..	3
12	..	..	..	4	2	..	6
13	..	..	..	4	1	..	5
14	..	..	..	..	..	..	..
15	..	..	..	1	..	..	1
16	..	..	..	..	1	..	1
17	..	..	..	..	..	..	..
18	..	..	..	..	1	..	1
19	..	..	..	..	..	1	1
Total	3	10	5	10	5	1	34
Average length ♂ and ♀	..	9.6	10.0	12.6	14.2	19.0	..
— — ♂+♀	6.7	9.7		13.1		19.0	..

Stat. 4332. — Oct. 24th, 1930. — 55° 10′ N. Lat. 8° 13′ E. Long. Depth: 13 m. — Duration of fishing: 30 minutes.

Age group	I		II		III		IV		V		?	Total
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♂ + ♀
Length cm.												
8	1	..	..	..	..	..	..	..	..	..	..	1
9	4	3	..	..	..	..	..	..	..	..	..	7
10	7	..	1	..	..	..	..	..	..	..	..	8
11	11	7	3	8	..	..	..	..	..	..	..	29
12	6	8	8	8	..	..	..	..	..	..	..	30
13	3	1	4	5	..	..	..	..	..	..	..	13
14	..	..	8	5	..	..	..	..	..	..	..	13
15	..	..	3	5	..	..	..	..	..	..	..	8
16	..	..	2	6	..	..	..	..	..	..	..	8
17	..	..	1	1	1	..	..	..	..	..	..	3
18	..	..	..	..	2	..	..	..	..	..	..	2
19	..	..	1	..	..	..	..	..	..	..	..	1
20	..	..	..	..	1	1	..	..	..	..	..	2
21	..	..	..	..	1	1	..	..	..	..	..	2
22	..	..	..	..	1	2	..	..	..	..	..	3
23	..	..	..	..	2	1	..	1	..	..	1	5
24	..	..	..	..	1	2	1	3	..	..	..	7
25	..	..	..	..	..	..	1	1	..	..	..	2
26	..	..	..	..	..	..	..	..	..	..	..	..
27	..	..	..	..	..	..	..	..	1	1	..	2
28	..	..	..	..	..	..	..	..	..	2	..	2
29	..	..	..	..	..	..	..	..	..	1	..	1
Total	32	19	31	38	9	7	2	5	1	4	1	149
Average length ♂ and ♀	10.8	11.2	13.4	13.3	20.7	22.3	24.5	24.0	27.0	28.0	23.0	..
— — ♂ + ♀	10.9		13.3		21.4		24.1		27.8		23.0	..

Stat. 4333. — Oct. 24th, 1930. — 55° 10′ N. Lat. 8° 00′ E. Long. Depth: 19 m. — Duration of fishing: 30 minutes.

Age group	0	I		II		III		IV	V		VI	VII	?	Total
Sex	♂ + ♀	♂	♀	♂	♀	♂	♀	♀	♂	♀	♂ + ♀	♀	♀	♂ + ♀
Length cm.														
6	3	..	..	..	..	..	..	..	..	..	..	..	..	3
7	7	..	..	..	..	..	..	..	..	..	..	..	..	7
8	1	..	..	..	..	..	..	..	..	..	..	..	..	1
9	..	3	2	..	..	..	..	..	..	..	..	..	..	5
10	..	9	3	..	1	..	..	..	..	..	..	..	..	13
11	..	1	1	2	1	..	..	..	..	..	..	..	..	5
12	..	2	1	6	5	..	..	..	..	..	..	..	..	14
13	..	..	2	6	4	..	..	..	..	..	..	..	..	12
14	..	..	..	..	4	..	..	..	..	..	..	..	..	4
15	..	..	..	..	4	..	..	..	..	..	..	..	..	4
16	..	..	..	1	2	..	..	..	..	..	..	..	..	3
17	..	..	..	1	1	..	..	..	..	..	..	..	..	2
18	..	..	..	..	..	1	..	..	..	..	..	..	..	1
19	..	..	..	..	..	..	..	..	..	..	..	..	..	..
20	..	..	..	..	..	..	1	..	..	..	..	..	..	1
21	..	..	..	..	..	2	..	..	..	..	..	..	..	2
22	..	..	..	..	..	..	..	..	..	..	..	..	..	..
23	..	..	..	..	..	3	1	1	..	..	..	..	..	5
24	..	..	..	..	..	..	2	..	..	1	..	..	..	3
25	..	..	..	..	..	..	1	1	..	..	..	..	..	2
26	..	..	..	..	..	..	..	..	..	1	..	..	..	1
27	..	..	..	..	..	..	..	..	..	1	..	1	..	2
28	..	..	..	..	..	..	..	..	1	2	..	..	1	4
29	..	..	..	..	..	..	..	..	1	..	..	..	..	1
30	..	..	..	..	..	..	..	..	..	1	..	..	1	2
31	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Total	11	15	9	16	22	6	5	2	2	7	..	1	2	98
Average length ♂ and ♀	..	10.1	10.8	12.8	13.5	21.5	23.2	24.0	28.5	27.7	..	27.0	29.0	..
— — ♂ + ♀	6.8	10.4		13.2		22.3		24.0	27.9		..	27.0	29.0	..

Stat. 4334. — Oct. 24th, 1930. — 55° 10′ N. Lat. 7° 37′ E. Long. Depth: 20 m. — Duration of fishing: 30 minutes.

Age group	I		II		III		IV		V	?		Total
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♂	♀	♂+♀
Length cm.												
11	2	..	2	1	..	..	..	..	..	..	..	5
12	..	..	11	8	..	..	..	..	..	..	..	19
13	2	1	15	7	..	..	..	..	..	1	1	27
14	..	..	16	10	..	..	..	..	..	..	..	26
15	..	..	9	9	..	..	..	..	..	..	..	18
16	..	..	8	7	..	..	..	..	..	..	1	16
17	..	..	5	5	..	..	..	..	..	..	..	10
18	..	..	2	1	..	..	..	..	..	..	..	3
19	..	..	..	4	..	..	..	..	..	1	..	5
20	..	..	..	2	1	..	..	..	..	..	..	3
21	..	..	..	1	..	2	..	..	..	..	1	4
22	..	..	..	..	..	2	1	1	..	..	..	4
23	..	..	1	..	..	1	..	..	..	..	..	2
24	..	..	..	..	..	..	..	..	1	..	..	1
25	..	..	..	..	..	..	..	..	1	..	2	3
26	..	..	..	..	..	..	2	1	..	..	..	3
27	..	..	..	..	..	1	..	..	..	..	..	1
Total	4	1	69	55	1	6	3	2	2	2	5	150
Average length ♂ and ♀	12.0	13.0	14.2	15.0	20.0	22.7	24.7	24.0	24.5	16.0	20.0	..
— — ♂+♀	12.2		14.6		21.5		24.4		24.5	18.9		..

Stat. 4335[1]). — Oct. 25th, 1930. — 55° 20′ N. Lat. 7° 37′ E. Long. Depth: 25 m. — Duration of fishing: 30 minutes.

Age group	I		II		III		IV		V		?	Total
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♂+♀
Length cm.												
11	3	9	..	..	..	..	..	..	..	..	..	12
12	12	3	4+1*	3	..	..	..	..	..	..	..	42
13	5+2*	4	16	19+1*	..	..	..	..	..	..	..	88
14	5	1*	22	16+1*	..	..	..	..	..	..	..	103
15	1	..	16	15	..	..	..	..	..	..	..	73
16	1	..	11	8	..	..	..	..	..	..	..	64
17	..	..	4	5+1*	..	..	..	..	..	..	..	29
18	..	..	2	2	1	..	..	..	..	..	..	27
19	..	..	1	1	1*	1	..	..	..	..	..	11
20	..	..	1	1	2	2	..	..	..	..	1	17
21	..	..	..	..	4	..	..	..	..	..	..	16
22	..	..	..	..	3	2	..	..	..	..	..	14
23	..	..	..	..	1	2	..	1	..	..	..	19
24	..	..	..	..	..	1	..	1	..	..	..	7
25	..	..	..	..	1	..	2	..	1	..	..	9
26	..	..	..	..	2	1	..	..	..	..	..	5
27	..	..	..	..	..	..	..	..	..	..	..	3
28	..	..	..	..	..	..	..	..	..	..	..	2
29	..	..	..	..	..	..	..	..	..	1	..	3
30	..	..	..	..	..	..	..	..	..	1	..	2
31	..	..	..	..	..	..	..	..	..	1	..	1
32	..	..	..	..	..	..	..	..	..	..	..	1
Total determined for Age	27+2*	16+1*	77+1*	70+3*	14+1*	9	2	2	1	3	..	..
Total caught ♂+♀	78		367		74		15		12		2	548
Average length ♂ and ♀	12.7	11.7	14.6	14.6	22.0	22.0	25.0	23.5	25.0	30.0	20.0	..
— — ♂+♀	12.3		14.6		22.0		24.2		28.8		20.0	..

[1]) The figures marked with an asterisk indicate plaice caught in the extra cod-end.

Stat. 4336. — Oct. 25th, 1930. — 55° 20′ N. Lat. 7° 17′ E. Long. Depth: 24 m. — Duration of fishing: 30 minutes.

Age group	I	II		III		IV		V		VI	VII	VIII	?	Total
Sex	♂	♂	♀	♂	♀	♂	♀	♂	♀	♂ + ♀	♂ + ♀	♀	♀	♂ + ♀
Length cm.														
12	1	..	..	..	..	..	..	..	..	..	..	..	..	1
13	..	2	1	..	..	..	..	..	..	..	..	..	..	3
14	..	2	3	..	..	..	..	..	..	..	..	..	..	5
15	..	6	4	..	..	..	..	..	..	..	..	..	..	10
16	..	1	1	..	..	..	..	..	..	..	..	..	..	2
17	..	6	2	..	..	..	..	..	..	..	..	..	..	8
18	..	2	2	..	..	..	..	..	..	..	..	..	..	4
19	..	..	..	4	..	..	..	..	..	..	..	..	..	4
20	..	1	1	1	..	1	..	..	..	..	..	..	..	4
21	..	..	..	4	..	1	..	..	..	..	..	..	..	5
22	..	..	..	4	2	..	..	..	..	..	..	..	..	6
23	..	..	..	6	1	1	1	..	..	..	..	..	..	9
24	..	..	..	2	3	1	..	..	..	..	..	..	..	6
25	..	..	..	2	5	1	2	2	1	..	..	..	..	13
26	..	..	..	1	1	2	..	1	..	..	..	..	1	6
27	..	..	..	..	..	..	1	3	2	..	..	..	..	6
28	..	..	..	..	..	..	..	2	1	..	..	..	..	3
:	..	..	..	..	..	..	..	..	..	..	..	..	..	..
42	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Total	1	20	14	24	12	7	4	8	4	..	..	1	1	96
Average length ♂ and ♀	12.0	15.9	15.8	22.1	24.2	23.6	25.0	26.6	26.8	..	..	42.0	26.0	..
— — ♂ + ♀	12.0	15.9		22.8		24.1		26.7		..	..	42.0	26.0	..

Stat. 4337[1]). — Oct. 25th, 1930. — 55° 10′ N. Lat. 7° 17′ E. Long. Depth: 22 m. — Duration of fishing: 30 minutes.

Age group	I		II		III		IV	V	Total
Sex	♂	♀	♂	♀	♂	♀	♀	♂	♂ + ♀
Length cm.									
12	..	1	1*	..	..	..	..	..	2
13	1	5	6 + 1*	..	..	..	..	..	17
14	1	1	8 + 1*	4	..	..	..	..	33
15	1	1	19 + 1*	9	..	..	..	..	58
16	..	..	10	7	..	..	..	..	35
17	..	..	2	4	1	..	..	..	12
18	..	..	5	6	..	..	..	..	18
19	..	..	2	..	1	..	..	..	7
20	..	..	1	..	..	..	..	..	3
21	..	..	1	..	4	..	..	..	10
22	..	..	..	1	1	1	..	..	11
23	..	..	..	..	3	2	..	..	7
24	..	..	..	..	2	1	..	..	5
25	..	..	..	..	..	..	1	..	1
26	..	..	..	..	..	..	..	..	..
27	..	..	..	..	..	..	..	..	..
28	..	..	..	..	..	..	..	1	1
Total determined for Age	3	8	58	31	12	4	1	1	..
Total caught ♂ + ♀	17		171		30		1	1	220
Average length ♂ and ♀	14.0	13.2	15.4	16.2	21.6	23.0	25.0	28.0	..
— ♂ + ♀	13.4		15.7		22.0		25.0	28.0	..

[1]) The figures marked with an asterisk indicate plaice caught in the extra cod-end.

Stat. 4338. — Oct. 25th, 1930. — 55° 10′ N. Lat. 6° 47′ E. Long. Depth: 30 m. — Duration of fishing: 30 minutes.

Age group	II		III		IV		V		?		Total
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂ + ♀
Length cm.											
16	..	2	..	..	..	..	..	..	..	..	2
17	3	2	..	..	..	..	..	..	..	..	5
18	4	6	1	..	..	..	..	..	..	..	11
19	2	3	2	..	..	..	..	..	..	..	7
20	2	3	..	2	..	..	..	..	..	..	7
21	3	1	3	..	..	..	..	..	..	..	7
22	2	1	8	4	1	..	..	..	..	..	16
23	..	..	14	6	..	1	..	..	..	..	21
24	..	..	10	4	1	..	..	..	1	..	16
25	1	..	7	9	1	..	..	..	..	..	18
26	1	1	7	1	2	1	..	..	1	1	15
27	..	..	2	3	1	..	1	..	..	..	7
28	..	..	..	1	..	2	2	1	..	..	6
29	..	..	..	..	..	2	2	..	..	1	5
30	..	..	..	..	..	..	1	1	..	..	2
31	..	..	..	..	..	..	..	1	..	..	1
Total	18	19	54	30	6	6	6	3	2	2	146
Average length ♂ and ♀	19.9	18.9	23.5	24.1	25.0	27.2	28.5	29.7	25.0	27.5	..
— — ♂ + ♀	19.4		23.7		26.1		28.9		26.2		..

Stat. 4339. — Oct. 25th, 1930. — 55° 20′ N. Lat. 6° 47′ E. Long. Depth: 34 m. — Duration of fishing: 30 minutes.

Age group	II	III		Total
Sex	♀	♂	♀	♂ + ♀
Length cm.				
20	..	1	..	1
21	1	1	1	3
22	..	..	1	1
23	..	..	1	1
24	..	1	..	1
25	..	..	1	1
26	..	..	1	1
Total	1	3	5	9
Average length ♂ and ♀	21.0	21.7	23.4	..
— — ♂ + ♀	21.0	22.8		..

Stat. 4340. — Oct. 25th, 1930. — 55° 27′ N. Lat. 6° 47′ E. Long. Depth: 33 m. — Duration of fishing: 30 minutes.

Age group	II		III		IV		V	Total
Sex	♂	♀	♂	♀	♂	♀	♀	♂ + ♀
Length cm.								
16	1	2	..	..	..	..	..	3
17	1	..	..	..	..	..	..	1
18	1	2	..	..	..	..	..	3
19	1	1	..	..	..	..	..	2
20	2	2	..	..	..	..	..	4
21	1	..	2	2	..	..	..	5
22	..	1	2	1	..	..	..	4
23	1	..	..	2	..	1	..	4
24	..	..	2	1	..	..	..	3
25	..	..	..	1	..	1	..	2
26	..	..	..	..	..	1	..	1
27	..	..	..	..	1	..	..	1
28	..	..	..	..	..	..	..	..
29	..	..	..	..	..	..	1	1
Total	8	8	6	7	1	3	1	34
Average length ♂ and ♀	19.2	18.6	22.3	22.7	27.0	24.7	29.0	..
— — ♂ + ♀ ..	18.9		22.5		25.2		29.0	..

Stat. 4341[1]). — Oct. 25th, 1930. — 55° 27′ N. Lat. 7° 17′ E. Long. Depth: 30 m. — Duration of haul: 30 minutes.

Age group	I		II		III		IV		V	?		Total
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♀	♂	♀	♂ + ♀
Length cm.												
13	..	..	..	1	..	..	..	..	..	..	..	1
14	1	1	7	8	..	..	..	..	..	..	..	33
15	1	3	15+1*	9	..	..	..	..	..	..	..	61
16	2	2	31	21	..	..	..	..	..	..	..	102
17	..	..	31	28	..	..	..	..	..	..	..	106
18	..	..	24	18	..	..	..	..	..	..	1	83
19	..	..	10	12	5	..	..	..	..	..	..	40
20	..	..	5	..	3	4	..	..	..	..	..	23
21	..	..	1	4	5	5	..	..	..	1	..	25
22	..	..	1	..	3	3	..	..	..	2	..	21
23	..	..	..	..	5	6	..	..	..	..	..	15
24	..	..	..	..	1	5	..	..	..	..	..	12
25	..	..	..	..	1	1	1	..	..	..	..	3
26	..	..	..	..	1	..	..	..	1	..	..	4
27	..	..	..	..	..	..	..	..	..	..	..	1
28	..	..	..	..	..	..	..	1	..	..	..	1
29	..	..	..	..	..	..	..	..	1	..	..	1
Total determined for Age	4	6	126	101	24	24	1	1	2	3	1	..
Total caught ♂ + ♀	20		416		81		3		3	9		532
Average length ♂ and ♀	15.2	15.2	16.9	16.9	21.5	22.2	25.0	28.0	27.5	21.7	18.0	..
— — ♂ + ♀	15.2		16.9		21.8		26.5		27.5	20.8		..

[1]) The figures marked with an asterisk indicate plaice caught in the extra cod-end.

Stat. 4342. — Oct. 27th, 1930. — 55° 27′ N. Lat. 7° 37′ E. Long. Depth: 26 m. — Duration of fishing: 30 minutes.

Age group	I	II		III		IV		V		?	Total
Sex	♂	♂	♀	♂	♀	♂	♀	♂	♀	♀	♂ + ♀
Length cm.											
12	1	..	..	..	..	..	..	..	..	..	1
13	..	2	1	..	..	..	..	..	..	..	3
14	..	..	1	..	..	..	..	..	..	..	1
15	..	1	2	..	..	..	..	..	..	..	3
16	..	2	..	..	..	..	..	..	..	..	2
17	..	1	1	1	..	..	..	..	..	..	3
18	..	4	..	..	..	..	..	..	..	..	4
19	..	1	2	1	..	..	..	..	..	..	4
20	..	..	2	..	1	..	..	..	..	..	3
21	..	..	..	..	1	..	..	..	..	..	1
22	..	..	..	..	..	..	..	..	..	..	..
23	..	..	..	1	3	..	..	..	..	..	4
24	..	..	..	1	..	1	1	..	..	1	4
25	..	..	..	2	..	..	..	..	..	..	2
26	..	..	..	..	..	2	2	..	..	..	4
27	..	..	..	..	..	1	1	1	1	..	4
28	..	..	..	..	..	2	..	1	1	..	4
29	..	..	..	..	..	1	1	..	..	..	2
30	..	..	..	..	..	..	..	1	1	..	2
31	..	..	..	..	..	..	..	..	..	..	..
32	..	..	..	..	..	..	..	..	1	..	1
Total	1	11	9	6	5	7	5	3	4	1	52
Average length ♂ and ♀	12.0	16.5	17.0	22.2	22.0	26.9	26.4	28.3	29.2	24.0	..
— — ♂ + ♀	12.0	16.7		22.1		26.7		28.9		24.0	..

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